ORIGINAL ACRST-3043

# OFFICIAL TRANSCRIPT OF PROCEEDINGS

## NUCLEAR REGULATORY COMMISSION

### ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

**Title:** SUBCOMMITTEE ON ADVANCED REACTOR DESIGNS

TR04 (ACRS)
RETURN ORIGINAL
TO BJWHITE
M/S T-2E26
415-7130
THANKS!

**Docket No.:**

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PAGES: 236 - 310



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## UNITED STATES NUCLEAR REGULATORY COMMISSION'S
## ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

JUNE 18, 1998

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on June 18, 1998, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

This transcript had not been reviewed, corrected and edited and it may contain inaccuracies.

UNITED STATES NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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SUBCOMMITTEE ON

ADVANCED REACTOR DESIGNS

U.S. Nuclear Regulatory Commission
11545 Rockville Pike
Room 2B-3
Rockville, Maryland 20852-2738

Thursday, June 18, 1998

The Subcommittee met pursuant to notice at 8:30 a.m.

MEMBERS PRESENT:
JOHN J. BARTON, Chairman, ACRS
MARIO H. FONTANA, Member, ACRS
ROBERT SEALE, Member, ACRS
DANA A. POWERS, Member, ACRS
DON W. MILLER, Member, ACRS
GEORGE E. APOSTOLAKIS, Member, ACRS

PROCEEDINGS

[8:30 a.m.]

CHAIRMAN BARTON: The meeting will now come to order.

This is the second day of a meeting of the ACRS Subcommittee on Advanced Reactor Designs.

I'm John Barton, Chairman of the Subcommittee.

ACRS members in attendance are George Apostolakis, Mario Fontana, Don Miller, Dana Powers, and Robert Seale.

We also have in attendance ACRS consultant James Carroll.

The purpose of this meeting is to continue review of the Westinghouse AP600 design.

Today the Subcommittee will review containment spray system design, security system design, WCAP-14477, adverse interactions evaluation report, answers to open ACRS questions, and discussion and review of the proposed ACRS report on the AP600 design.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and action as appropriate for deliberation by the full committee.

Noel Dudley is the cognizant ACRS staff engineer for this meeting.

Rules for participation in today's meetings have been announced as part of the notice of this meeting previously published in the Federal Register on May 22, 1998.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have received no written comments or requests for time to make oral statements from members of the public.

We will now proceed with the meeting, and I call upon Brian McIntyre of Westinghouse to begin.

MR. McINTYRE: Okay. Thank you, Mr. Barton.

The first presentation today will be Terry Schulz on discussing the containment spray system design for the AP600.

The second scheduled topic is security and then followed by the adverse systems interaction.

If you don't mind, I'd like to reverse the adverse systems interactions and the security. The security reviewer won't be here until nine and hasn't seen what I'm going to present, and at least he should have a few minutes to look at it.

CHAIRMAN BARTON: Sounds like a real good security system to me.

MR. McINTYRE: And then Mr. Schulz, if he gets done, can then jump in his car and be back at work by noon.

CHAIRMAN BARTON: Well, we'll have lots of questions for Mr. Schulz.

That's fine.

MR. McINTYRE: Okay. We bring you Mr. Schulz again.

MR. SCHULZ: Good morning. My name is Terry Schulz, and the first topic we'd like to discuss is the containment spray system for AP600.

This system is not a safety-related system. It's not required to function during design basis accidents. The doses for AP600 are limited to acceptable values with natural removal mechanisms.

The system is required by SECY-97-044 to provide additional capability in severe accidents. It's not required to be safety-related to perform that function.

The design of the system uses the fire water protection system to provide water from a water supply, the tanks, and pressure for the spray.

There's a connection made to the fire protection system inside containment that connects up to two ring headers that are located up in the top of the containment. These nozzles are at least 100 foot above the operating deck of the containment.

The fire protection -- one of the fire protection pumps, either one, provides a little more than 1,000 gpm at 20 psi.

We use 20 psi because of the severe accident studies that we looked at. The pressure in the containment is no more than 20 psi at about an hour or so after the accident, when we would anticipate the operators possibly using this system.

The spray nozzles provide essentially 100-percent coverage above the operating deck. The 83 percent comes about because there's obviously regions below the operating deck that aren't sprayed.

The system was set up to run for about three hours.

The system cannot run indefinitely, because it's just pumping water into the containment, and we have established a maximum water level that we want to allow during this system operation, and at this flow rate, we've got about three hours of operation.

DR. CARROLL: I've made this comment before, but I'll make it again. Do the fire insurance underwriters like your idea of compromising their fire protection system? Having fought a battle of that sort once, I'm sensitive to the issue.

MR. SCHULZ: We have not talked to insurance people about this. There are in existing plants some uses of the fire system for limited back-up kind of make-ups to either aux feed water or, in some cases, service water -- or not service water -- CCW make-up, that kind of thing.

As long as there is very careful control of the use of that, both from a -- say, operator procedures and a mechanical type -- you know, what it takes to turn this on -- and one of the things you see here, that in order to get spray, we need to open this air-operated valve inside containment, we need to open this lock-closed valve outside, which is a containment isolation valve, and to actually get water from the fire pumps, we need to open a third valve.

So, it's very unlikely or incredible to us that this would get inadvertently used, and we think that the situation where you've actually damaged the core -- this is a severe accident management kind of a thing, far beyond any design basis situation.

So, we think that's a reasonable approach, but we haven't actually discussed that. We haven't had an issue, as far as I know, with the NRC staff.

MR. SNODDERLY: This is Mike Snodderly, Containment Systems and Severe Accident Branch.

Dr. Carroll, if you notice, in the original design, either the primary or the second fire protection tanks could be use to supply the system.

As a result of discussions with our fire protection people, they didn't like that, and the system's been changed so that now only the secondary tank, the 350,000-gallon tank, is the only tank that can supply the spray system.

So --

DR. SEALE: So, you've scratched off the 425

MR. SNODDERLY: Right. And that is to be totally dedicated for just fire protection purposes, and that was as a result of comments from our fire protection people.

DR. CARROLL: Okay.

DR. SEALE: And there is no make-up from the sump internal to the containment for this.

MR. SCHULZ: That is correct. It's strictly in a external spray into the containment. There is no-recirc capability.

DR. SEALE: Either for the sprays or for the fire headers.

MR. SCHULZ: That's correct, yes.

So, you see here the basic arrangement, and as I mentioned, the connection, what was added to the design was this connection from the fire header inside containment up to the spray nozzles, including this air-operated valve.

This valve is a fail-open valve, so that if you actually had severe conditions in containment, it would expect it to be already open. Air would have been shut off to the valve, that kind of thing, and even if it wasn't open, it could be opened.

Originally, I think we had a fail-closed valve, and that probably would not be expected to function in a adverse condition inside containment. So, we changed it.

During a shut-down mode of operation, I'll point out that this additional manual valve here is closed so that the -- you can open up the fire header inside containment for potential fire-fighting duties without risking inadvertent spray in the containment.

So, again, the basic idea is that you've got 300,000 gallons of water or so that you can put into the containment.

The system can run for about three hours in that situation, and the containment water level will stay within acceptable levels, within a foot or so of the levels that you might reach otherwise in the containment.

DR. SEALE: Let me make sure I understand.

MR. SCHULZ: Sure.

DR. SEALE: The smaller of the two reservoirs over there on the right is now the only one available for the sprays. The other one is still there, but it's strictly dedicated to fire protection.

MR. SCHULZ: Right. Right.

DR. SEALE: Okay.

DR. CARROLL: And that's done by administrative controls, or is it physically impossible to use it?

MR. SNODDERLY: I believe it's administrative control, because the system's design -- I probably mis-spoke when I said the system design change -- how the system will be used.

DR. CARROLL: Okay.

MR. SCHULZ: Yes. There's valves in this ring header that I don't show here, that separate it out, and those valves will be used, along with the procedures, to provide that control.

When would the system be used?

Again, its purpose is a severe accident kind of capability.

So, we would use the core exit thermo-couple high temperature, which is an indication of loss of core cooling, and get into the emergency procedures and the severe accident management guidelines before this system would be used by the operators.

I mentioned it would be run continuously until it pumped in its 300,000 gallons of water or so. The containment water level is limited. Post-accident monitoring, qualified containment water level instruments verify that the level is not too high.

It does help with the removal of iodine. You get about a 50-percent reduction in iodine by running the system in this way.

DR. FONTANA: Is that figured on elemental or aerosols or both?

MR. SCHULZ: Aerosols.

DR. FONTANA: Okay.

MR. SCHULZ: Exactly --

DR. FONTANA: There's no pH control in the sprays, are there?

MR. SCHULZ: There's no pH control in the spray. You'll see in a slide we did evaluate the impact of putting this water into the spray, into the containment and what it would have affect on the pH, and it is minor and insignificant.

CHAIRMAN BARTON: Terry, this water level, less 109 foot elevation -- how many hundred thousand gallons is that?

MR. SCHULZ: That's 300,000 gallons.

DR. FONTANA: About 45,000 cubic feet.

MR. SCHULZ: We normally flood up to about 107 foot elevation, but we don't flood all the volumes to get to that level. There's -- the PXS rooms and the CVS rooms don't normally flood.

If we do flood all the volumes, you're down around the 103 level --

DR. FONTANA: Okay.

MR. SCHULZ: -- when you get like a wall-to-wall flood.

DR. FONTANA: Yes.

MR. SCHULZ: So, you go -- you would go from like the 103 level up to the 109 level by adding 300,000 gallons of water.

So, it may be a little confusing. If you're used to thinking of our re-circ level as 107 plus and we add that much water, you know, does it really make sense that we're only going up a foot or two, and there's other volumes that we would end up flooding in this situation.

I was just saying that the amount of -- the benefit of the system is somewhat dependent on the sequence of events and the timing. We've done some sensitivity studies of starting at one hour, hour-and-a-half, two hours after the source term that we used in the SSAR.

You get some variation but not a lot in the benefit of iodine reduction.

We had to tried to assure ourselves that the addition of this system doesn't cause any serious adverse problems.

One of the things that we looked carefully at, was it possible to have an inadvertent spray, and as I showed you, there's these three valves that have to be realigned, mis-positioned, open up in order to cause spray. So, we have concluded that that's not credible.

DR. APOSTOLAKIS: What kind of probability would you think that event has?

MR. SCHULZ: Totally insignificant, beyond calculation.

We've got one lock-closed manual valve that's a containment isolation valve. So, that's got a very high degree of assurance.

Typically, that one valve is enough to not assume that -- in design basis space -- that a system is realigned. However, that by itself would not give you a insignificant probability.

But combined with these other two, in my understanding of the PRA, it wouldn't even be modeled in the PRA. It would be thrown out by screening-type criteria. So, I don't know what the number would be, but in my opinion, it would be completely insignificant.

DR. SEALE: Is this the moral equivalent of the conservatisms that are in the thermal hydraulics calculations?

If I take a little over 1,000 gallons per minute and divide it into 350,000 gallons in that tank, I get over five hours of capacity, and you indicate you have three hours.

MR. SCHULZ: Yes.

DR. SEALE: Is that just conservancy?

MR. SCHULZ: That's just conservatism, yes. It could run --

DR. CARROLL: The tank had already been sized.

MR. SCHULZ: The tank's already been sized.

DR. SEALE: I appreciate it, but it's more than five hours, it's not three hours.

CHAIRMAN BARTON: In three hours you put like 186,000 gallons.

DR. SEALE: Yes.

MR. SCHULZ: Yes.

DR. SEALE: So, it is the moral equivalency of neglecting the heat capacity in the containment pressure calculation.

MR. SCHULZ: But the containment pressure, I don't think is --

DR. SEALE: That's another issue we dealt with the other day.

MR. SCHULZ: Right. The procedure would be to keep running that water in there. So, if the water is really available and it doesn't cause the water level to go above the 109, you'd really get your four or five hours.

DR. SEALE: Yes.

DR. FONTANA: What do the operators require to start this thing up?

MR. SCHULZ: Say again?

DR. FONTANA: What signals?

CHAIRMAN BARTON: It gets you into the severe accident management guideline.

MR. SCHULZ: This is a very key input into getting into the severe accident management guidelines, and there's a number of steps that you start taking --

DR. FONTANA: Okay.

MR. SCHULZ: -- once you get into here in terms of trying to get the reactor system pressure down to avoid a high-pressure melt-type sequence, to dumping the IRWST to establish the ex-vessel cooling, and another action in that list would be to line up the spray system and to -- so that it can be used when it's judged appropriate to use it.

DR. FONTANA: Now, if your thermo-couples don't work, you don't run. Is that correct?

MR. SCHULZ: Not by procedures. If you had no indication of high core exist thermo-couple temperatures, there's other temperature indicators in the hot legs. You know, you're into something --

DR. CARROLL: You've also got radiation monitoring.

MR. SCHULZ: You've got radiation monitors, although I don't know how --

CHAIRMAN BARTON: Is there a dome monitor in this containment, radiation dome monitor?

MR. SCHULZ: There's several -- I don't know if they're actually located in the dome, but they're in the atmospheric space.

DR. CARROLL: I think Reg. Guide 1.97 tells you it has to be up there.

CHAIRMAN BARTON: You have to have one up there, right?

DR. CARROLL: I think so.

MR. SCHULZ: So, we think that, in our minds, we're relying on these core exist thermo-couples to give us a very clear signal to the operators of when to do it, when not to do it, so that we can not get into situations where it -- the operators might inadvertently decide, oh, gee, I think I need it and turn it on in design basis accidents. So, the clear and unambiguous indication is an important part of this judgement that the inadvertent spray during design basis-type accidents are not a credible event.

CHAIRMAN BARTON: Does the staff agree that it's not credible and requires misalignment of three valves for inadvertent containment spray?

MR. SNODDERLY: This is Mike Snodderly.

I don't know if I would use the word "incredible," because we didn't do the analysis or the PRA, but we felt that it was sufficient to preclude the need for --

CHAIRMAN BARTON: The reason I ask is because, in a discussion on leak before break in feedwater, it requires the same kind of thing, misalignment of several valves, get the water hammer, and you guys thought it was credible. So, I just -- that's why I asked.

DR. CARROLL: I think I would strike the word "credible" from our nuclear vocabulary. It has caused a lot of trouble over the years.

DR. APOSTOLAKIS: Highly unlikely.

CHAIRMAN BARTON: Highly unlikely.

DR. CARROLL: That sounds better.

MR. SCHULZ: Other design basis evaluations we performed were evaluation of boron dilution -- and again, key to this evaluation was the going-in assumption, based on the previous page, that spray -- inadvertent spray is not an event that you have to consider in design basis space, it's only used in severe accident.

In severe accidents, the core is severely damaged, its geometry is changed, and the need for boron is not a requirement anymore. So, as a result, boron dilution is not a concern, and we have not evaluated it.

DR. CARROLL: This change of core geometry is always in the direction of making the core less reactive?

MR. SCHULZ: That's my understanding. I'm not an expert in that area, but there also tends to be less space for water to get, you know, in -- that's part of it.

Containment pH we looked at, and we actually did a little sensitivity study where we put in 300,000 gallons of water and looked at our long-term pH calculation, and the indications were that the pH would increase but only very slightly, and as a result, we don't think there's any issue with re-evolvement of iodine.

DR. SEALE: Basically no problem.

MR. SCHULZ: No problem.

DR. CARROLL: And in your modeling, you did have the tri-sodium phosphate.

MR. SCHULZ: We had tri-sodium phosphate.

DR. CARROLL: It is buffered with tri-sodium phosphate as you're adding this neutral water.

MR. SCHULZ: Right. We attempted to account for the sulfuric acid from cable degradation, nitric acid from the air.

DR. POWERS: I think, at one time, I asked what G value you're using for your nitric acid in the air.

MR. SCHULZ: I don't know the answer to that. I didn't do the calculation myself. I'm not aware.

DR. POWERS: Do you know where that calculation was done?

MR. SCHULZ: Fauske & Associates did the calculation for us. I think it was made available for staff review and they did look at it. I don't know -- far as I know, there was no -- they considered there was no problem with it, but I don't know what the extent of their review was.

DR. POWERS: You indicated that putting in 300,000 gallons of spray increases the pH?

MR. SCHULZ: No.

DR. POWERS: It decreases.

MR. SCHULZ: Decreases the pH, yes. I didn't really say that there, but --

DR. CARROLL: Yes, you did.

CHAIRMAN BARTON: Just said changes.

DR. CARROLL: Decreases.

MR. SCHULZ: No, decreases. It's kind of removed from the pH there, 30 days are in the middle, so it's -- yes, you're right, I did. It does decrease it.

DR. POWERS: Phosphate interacts with a lot of things to form precipitates. Is there a concern about the phosphate loss, consequently a loss of buffering capacity, due to interactions with lots of things -- concrete, steel, iron, contaminants, things like that?

MR. SCHULZ: I don't know the answer to that question. I would have to ask that if you wanted an answer.

DR. CARROLL: Put that on the Dudley list, Dana?

DR. POWERS: I think it's a back-of-the-envelope calculation, probably not a very big effect, as long as the phosphate solution is not in contact with concrete.

MR. SCHULZ: Well, there's coatings on concrete. AP600 has a lot of steel modules. So, it tends to have a bit less concrete than operating plants does, although there is still some

DR. POWERS: I assume most of the sumps are steel-lined, aren't they?

MR. SCHULZ: The sumps are steel-lined, but we do float up the loop compartment.

Now, the loop compartment walls are steel. The floor, I believe, is concrete.

DR. POWERS: Coated. Some sort of coating on it?

MR. SCHULZ: Yes. Yes. And the floor would be thick kind of a epoxy on the floor.

DR. POWERS: I suspect it's difficult to be -- to do the calculation in a way that persuades the more skeptical, but I'll bet you that, in reality, that you get some precipitation, but it's not enough to change, got enough -- in there to -- a lot of coveralls.

MR. SCHULZ: Yes, there is a lot.

We have committed to a number of ITAAC test inspections -- one, just to visually inspect that there are nozzles in the containment, in the spray headers.

There's a verification that the water fire protection pumps have adequate had flow, the water tank has adequate volume, and we've also added, more recently, a inspection to -- for valves that would be used to isolate the spray header from the normal fire protection system so that they can be aligned during normal operation and provide the desired separation and avoidance of inadvertent spray.

DR. SEALE: I remember several years ago, many years ago now, that in connection with an experimental facility that was steel-lined, a concern for electrical shock hazard was expressed and, let's say, administratively cleared, as I recall, and then, as it turned out later, someone, in fact, did get fatally injured from an electrical shock.

Is there any -- has there been any concern for these large rooms with essentially steel linings as being a peculiarly severe electrical hazard?

DR. CARROLL: Not if they're grounded, I don't think.

DR. SEALE: These were grounded, but -- I'm just curious. It was just something that was in the back of my mind.

MR. SCHULZ: I have not heard any concern raised, but I don't really -- I'm not really an expert in that area.

Are there any other questions?

DR. SEALE: Is there any problem along those lines that you're aware of, staff?

MR. SNODDERLY: No, sir.

DR. SEALE: Okay.

MR. SNODDERLY: That wasn't something we considered.

DR. CARROLL: I don't think there's any history in the nuclear industry of that sort of thing.

CHAIRMAN BARTON: Most of those compartments are basically concrete painted, shield or painted concrete compartments.

DR. SEALE: You're not working a steel tank.

CHAIRMAN BARTON: Steel-line compartments I don't think are prevalent in today's design.

DR. CARROLL: Well, your torse is a steel container.

MR. SCHULZ: The two-loop plants that are operating in the United States have steel containments.

CHAIRMAN BARTON: Oh, yes.

MR. SCHULZ: And the ice containments, I think, are steel.

CHAIRMAN BARTON: I think Bob's question was more towards [illegible] compartments -- at least our understanding was you're talking about sub-compartments within containment that had steel-lined walls or something.

DR. SEALE: Yes. You're truly grounded in something like that. I mean there's a good path to ground if you ever manage to come in contact with anything.

MR. SNODDERLY: The Mark I containment, that type of containment, you've got the steel torse, and I can't recall any incidents of electrocution.

DR. SEALE: Okay.

CHAIRMAN BARTON: Any other questions of Terry?

[No response.]

CHAIRMAN BARTON: Looks like not. Thank you.

DR. CARROLL: I think he got off easy today.

MR. SCHULZ: You'll have another chance here.

DR. POWERS: Is the staff going to have an opportunity to comment on what they did to review the nitric acid production?

If you have a G-value of .01, then, yes, you're not going to change the pH at all. If you use a G-value of 5, you'll probably change the pH by a lot. So, the question is what value was used?

MR. SCHULZ: We could get an answer to that.

MR. McINTYRE: We should be able to call back and find that.

DR. POWERS: It's a straightforward calculation. You need the dose to the atmosphere, and you need the amount of time, and you need a G-value.

CHAIRMAN BARTON: Are you taking that on as an action item, Brian?

MR. McINTYRE: Yes.

MR. SCHULZ: We performed an evaluation which we reported in a WCAP on adverse systems interaction for AP600. This was a very interesting exercise evaluation.

There's not exactly a rule book on how to do this kind of thing, and we found that, for the most part, we had done, piecemeal-wise, a rather good job in finding adverse interactions, but we had not done a very good job in describing that and conveying that information.

So, a lot of what was in this WCAP was pulling together information out of different areas of our design and analysis and presenting them in a systematic fashion to explain what has been done or hasn't been done.

There were three basic types of interactions that we looked for -- what we call functional interactions -- these are thermal hydraulic kind of things, two different systems running at the same time that might somehow interfere with each other -- human intervention interactions -- these are more of the errors of commission in most cases, possibly cognitive errors, and the spatial interactions. These are hazard-induced fire, flood, that kind of thing, that could possibly affect multiple systems.

We did go through and try to look at both the passive, safety-related systems and the active, non-safety-related systems, both in combinations of act of interfering or interacting with passive, as well as between passive systems.

DR. CARROLL: I'm curious about something, probably for the staff. Is this the first time a study as comprehensive as this one has been done on a new design?

MR. HUFFMAN: This is Bill Huffman, Projects.

I don't know the answer to that question. I'm getting feedback here for the evolutionary designs that such a similar study was done. I don't know how extensive it was.

DR. CARROLL: Why don't I remember that? I guess I'm getting old.

DR. SEALE: Well, I know Carlisle Michelson had quite a few questions along these lines.

DR. CARROLL: Yes. I think the study Westinghouse has done would have gone a long way to making Carl happy.

MR. HUFFMAN: The additional feedback I'm getting is that, in the evolutionary designs, it was in response to one of the USI-GSI generic issues for interaction. So, it may not have been as comprehensive.

DR. CARROLL: Thank you.

MR. SCHULZ: What I'd like to now do is to go through these three different types of interactions and try to explain what we did do.

In terms of the functional interactions, we tried to look at the potential or tried to discover potential adverse interactions, and the underlying basis for that was our understanding of AP600 system behavior, and that understanding has a lot of separate activities that form that understanding, going back to detailed hand-type calculations and evaluations, small-scale-type research that was done on AP600 features, larger separate effects testing that was done on AP600 features, and probably very important was the interval systems testing at SPES and OSU, where we actually did run some of the sequences with both active and passive systems functioning at the same time, as well as, obviously, the passive systems working together.

A lot of work and thinking goes into the DBA analysis to consider, and that's one of the fundamental jobs of the analysts that do the DBA analysis, is to think about what is the worst set of conditions.

So, they do -- historically have done a lot of thinking of how can the feedwater system malfunction, how can these other systems malfunction that are non-safety systems and adversely affect the course of an accident.

Now, AP600 throws a few wrinkles into that, because we have a little different mix of systems, but the fundamental part of DBA analysis is to do some of this thinking.

The PRA success criteria thermal hydraulic analysis is another large body of analysis that was done and has some of the same objectives.

More analysis was done in support of the ERGs.

So, together, this analysis, testing, and thinking about these -- the way the systems perform form the basis for our understanding of the plant.

Now, what we do with that understanding?

For this evaluation, we tried to put a matrix together of systems and -- active systems and basically passive systems or functions and then tried to look at where we thought there might be a potential interaction, and where you see these numbers, these are actually section numbers out of the WCAP, and so, in section 2.2.1, we basically discuss the potential of reactor coolant pumps to cause interactions with the core, core make-up tanks, and passive RHR.

We didn't consider in the other areas potential interactions, and again, this was based on our understanding of the plant.

I'm not going to through this whole table. There's a lot of information that's in WCAP. I do have basically an example to talk about, and that happens to be the reactor coolant pump item.

DR. APOSTOLAKIS: Did you consider potential interactions among active systems?

MR. SCHULZ: Not explicitly, but when we were -- in this review.

I think there was a less concern -- I think the concern as expressed by the staff was you have -- was the passive systems, because they are the primary defense in both -- of course, in DBA space, they are the defense that was relied upon to keep the plant safe.

In the PRA, they are the primary defense, provide most of the protection of the plant. If those things work, you're okay.

There was also this concern that, gee, passive systems are sensitive, small DPs, may be more subject to interactions.

So, I think those two factors led us to focus on the passive systems and whether or not active systems could adversely interact with them or between themselves, and we haven't really looked at active to active.

DR. APOSTOLAKIS: Or between themselves. You mean what?

MR. SCHULZ: Between core make-up tanks and passive RHR.

DR. APOSTOLAKIS: I see.

MR. SCHULZ: That kind of thing. And that's the next table I was going to show you. We did a similar kind o matrix for the passive features, which basically just lists the same systems on -- across the top and down below, and then to discuss the potential for interactions.

There's a few of them that we basically excluded, but most of them -- as you see, this is all filled in up here -- we discussed in the WCAP.

DR. APOSTOLAKIS: So, what was your conclusion?

MR. SCHULZ: The conclusion -- well, two more slides.

DR. APOSTOLAKIS: Okay. But even interactions among active systems -- I mean the guys who developed the event trees must have taken them into account. If you have more than one active system in an event tree, you really have to look for potential dependencies, right?

MR. SCHULZ: Well --

DR. APOSTOLAKIS: So, maybe it was not part of this study, but --

MR. SCHULZ: Absolutely, dependencies, if this system needs this one to work, and then I suppose the converse of that is, if this one doesn't work, that one doesn't work. So, absolutely.

DR. APOSTOLAKIS: What if they share --

MR. SCHULZ: Yes.

DR. APOSTOLAKIS: -- components and all of this.

MR. SCHULZ: Yes. From that point of view, the PRA -- that's one of the basic fundamental things that's done in the PRA, is to look for those interactions.

DR. APOSTOLAKIS: This study, then, was sort of special because of the introduction of the passive systems, you had to do this excellent work.

MR. SCHULZ: Yes. And to see if the -- to try to look for something that might have been missed in everything else you do.

DR. APOSTOLAKIS: Right.

MR. SCHULZ: This matrix here is primarily looking at Chapter 15 analysis, and again, there's multiple pages of this in the WCAP, and what it's looking at is listing the active systems and assumptions made in the SSAR, and basically, what this table summarizes is that there are a number of active systems in PWRs that historically -- and with AP600, also -- are potential adverse interaction situations. Excessive main feedwater is a good example.

And there are valves and controls and interlocks to minimize the potential, to prevent those kind of interactions.

AP600 typically has done maybe a little bit more in that area because of our -- in some cases, the passive systems allows us to automatically shut off start-up feedwater, because it's not the safety-related way of cooling the reactor in a transient.

So, if things get a little out of whack or start looking like threatening core cooling, we can turn off start-up feedwater. It's a very dangerous thing to do in a plant where that is your safety-related means of cooling.

The same thing with CVS make-up -- that's our high-pressure make-up, and so, if we have a potential pressurizer overfill situation developing, we can shut off the CVS without worrying too much that we're defeating our safety-related means of make-up.

DR. FONTANA: What are the entries again -- N.2, A.2, that sort of thing?

MR. SCHULZ: These are notes in the WCAP that --

DR. FONTANA: Oh, okay.

MR. SCHULZ: -- basically tell you something about the assumptions made in the safety analysis relative to this event versus this feature.

The next slide had a little example of active-passive kind of interaction and sort of illustrates the approach and what we did in these -- in little sections that dealt with -- so, you'll find a section in the WCAP on reactor coolant pumps, which is 2.2.1, and it basically goes through a function discussion, what the reactor coolant pumps do.

Of course, they circulate reactor coolant through the reactor coolant system, through the core, and during an event, their operation tend to increase the heat transfer out of the core, which is usually good and sometimes can actually cause interactions by itself.

Then we, understanding the context of the component you're talking about, thought about the potential interactions as we identified in that table, and there were like three of them.

One of them was core cooling, and what were thinking about here was, in particular, the small LOCA situation of running reactor coolant pumps during a small LOCA and then, possibly with the loss of the reactor coolant pumps, get core uncovery or something actually outside the design basis, and we deal with that in AP600 with automatic safety-related reactor coolant pump trip.

So, in a safety injection signal, we stop the reactor coolant pumps, and that prevents this adverse interaction, whereas in operating plants, they don't trip the pumps, they allow -- rely on the operators to trip them when they think it's appropriate.

The operation of the reactor coolant pumps can adversely -- or degrade to some degree the circulation through the core make-up tanks. Again, we automatically trip the reactor coolant pumps when we actuate the core make-up tanks to prevent that interaction.

Operation of the reactor coolant pumps enhances, increases passive RHR heat removal. Again, depending on the situation, that can either be good or can lead to some adverse interactions. During a steam line break, operation of the reactor coolant pumps tends to make the accident worse.

We do get into safety-related tripping of the reactor coolant pumps on a excessive cool-down kind of signal, which minimizes this effect, and then basically the passive RHR transitions from a forced circulation to a natural circulation mode, flows down, and so, the interaction is minimized.

So, in this particular case, in going through this process, there were potential adverse interactions.

They had already been dealt with in the design basically by automatic reactor coolant pump trip, which was a part of the design, and that the design basis accidents and PRA evaluations had accounted for this, and in fact, you see in the PRA -- was discussed yesterday in the level one that the core make-up tank/reactor coolant pump trip is typically treated as a -- both are necessary to get core make-up tanks.

So, kind of in summary for the functional interactions, a number of active/passive adverse systems interactions were identified. Many of them are the same kind of interactions you have in today's plants -- i.e., excessive feedwater kind of thing.

Some are unique to AP600, like the reactor coolant pump that I talked about. All of them are addressed, that we identified, in the DBA and the PRA analysis, and again, some of them require mitigating features like feedwater isolation or reactor coolant pump trip.

We did not identify any significant passive-passive interactions.

Now, there were some there. They are dealt with in the testing and the analysis. So, we don't do anything in terms of trying to control it by operator action or basically interlocks and control features.

We have identified the potential interaction and quantify that in the analysis of the plant.

Probably the most challenging aspect to this whole study was the human factors, human intervention. As you heard yesterday in our PRA level one discussion, the PRA accounts for, quantifies operator errors where the operator fails to take an action.

So, they quantify that kind of interaction, but they don't really quantify errors of commission, where the operator takes the wrong action.

As a result of that -- of PRA -- and also the fact, as you saw yesterday, that AP600 is relatively insensitive to operator actions, must less sensitive than operating plants.

So, what we looked at in this study was primarily cognitive-type errors, errors of commission that we tried to look at.

In talking with our human factors experts, they advised us that the kind of things that can lead to those problems are maybe three, three-fold, as they're outlined in the WCAP -- unfortunately, I didn't quite get them up here -- goal conflict kind of errors.

DR. APOSTOLAKIS: What conflict?

MR. SCHULZ: Goals, conflicts in goals, like what happened TMI, where you had the high head pumps running and you wanted the pumps to run, but you were overfilling the pressurizer.

So, the pumps running were -- there was a goal conflict there. That's one way of looking at it.

Now, AP600, with the passive systems, eliminates some of those fundamental goal conflicts from the plant.

The passive systems don't tend to cause some of those events that -- goal conflicts that the active systems do, or we can, like I say, isolate charging pumps or isolate start-up feedwater to eliminate that goal conflict, whereas in operating plants, those are your safety-related means and you've got to be careful about stopping them.

A second potential cognitive error you can get into with too much information, too little information to the operators.

Now, that's not something we can explicitly deal with here.

That's a objective we've taken on, and it's described the SAR in Chapter 18 for the man-machine interface design of the plant, which is ongoing and in the future, to provide the right amount of information and in the right way, in the right priorities.

Another thing that can cause cognitive errors is knowledge-based-type decisions, and again, Chapter 18 takes on commitments for the structure of the ERGs, the functional -- the task-based-type decisioning, decision-making, the symptom-based ERGs are a primary defense against that kind of a problem.

So, what did we do? We basically took the potential adverse interactions that we identified in the first part of this study, the functional adverse interactions, and we looked at each of those, and we asked ourselves some questions, and those three questions are kind of outlined --

DR. APOSTOLAKIS: You have a last bullet there that says safety versus economic consequences.

I don't see what the designer can do about it. I mean that's really for the owner and operator of the plant, the licensee, to make sure that we don't have conflicts there, but you guys cannot do it.

MR. SCHULZ: No, we can.

DR. APOSTOLAKIS: What can you do?

MR. SCHULZ: We did. By making the design so that it minimized -- this is kind of a goal conflict again, and one of the key examples is the feed-and-bleed cooling. You know, the goal is to cool the core and you're running out of options, you know, that is your kind of last resort option.

However, if you do turn that on, you mess up the containment. So, oh, gee, what do I do?

In AP600, we think we have done something to minimize that. You don't eliminate it but minimize it by design.

One, we're, in our minds, less likely to get into that situation, because we have more ways of cooling the core before we get into feed-and-bleed.

We have start-up feedwater, main feedwater, which a current plant's got to have. We have passive RHR, which is an extremely reliable passive system. If it works, you don't need to feed-and-bleed. So, that's one step.

The other step is that, if you get into feed-and-bleed cooling, we can get into that with almost no containment consequences, assuming the normal RHR pump works, and that is the normal procedure.

If you get into ADS and you only open the first three stages, which is when you initiate bleed out of the system, that's all you're really -- the operator is committing to.

He knows, in his current plant, that if he opens up the power-operated relief valve, he is going to very quickly burst the rupture disk out of the PRT and he's going to get steam into the containment.

AP600, we have this half-a-million-gallon tank, and the operator will know from the design and analysis anyway that if he gets into that situation and gets his normal RHR pump running, he won't steam the containment. So, now, yes, if that pump fails, then he gets into there.

So, we think we've done something along those lines. You can debate about how important that really is, how significant it is.

DR. APOSTOLAKIS: That's fine. We try to avoid situations where the operators would have these conflicts.

MR. SCHULZ: Yes.

DR. APOSTOLAKIS: Did human factors engineering do anything to you that you found useful?

MR. SCHULZ: That's a loaded question.

In this effort here, the discussion about what can lead to a cognitive error pretty much comes out of human factor kind of considerations in terms of the goal conflicts, too much, too little information, the knowledge-based decision, and then how we're trying to deal with that.

Now, some of it we can't do anything about now, it's a commitment for the future in terms of the control room --

DR. APOSTOLAKIS: That's not really human factors, though, but anyway, I see what you mean. But your design of the control room, perhaps, was influenced by human factors engineering, right?

MR. SCHULZ: Oh, tremendously, and that's still going on as the details go on, but yes, yes.

DR. APOSTOLAKIS: I remember.

MR. SCHULZ: So, there are a number of tables like this that are in the WCAP again, and there's a couple questions that we ask for each of these potential adverse interactions that we identified in the functional interaction part of the document.

The first question was, does an opportunity exist for the operator to make an error based on the procedures, and we had the ERGs that we looked in this part of the study.

So, in case of the reactor coolant pump versus core cooling, we said no, an opportunity doesn't exist, primarily because the -- first of all, the pumps trip automatically, so that the operators don't have the need and possibly make the error of not tripping them. There's also reactor coolant pump restart criteria that avoids adverse interactions in a recovery situation.

The second question was, are there safeguards against the human error, and again, in this case, the pumps are tripped automatically, and that's a safeguards -- the ERGs also provide a bit of a safeguards on the restart.

A third question is the adverse interaction modeled in the PRA, and in this case, you're really talking about the restart is not modeled. The tripping of the pump actually is modeled, but it's more in conjunction with the core make-up tank operation.

DR. APOSTOLAKIS: Okay.

MR. SCHULZ: And then there's kind of a conclusion, which is aimed at, you know, is there a concern with human intervention?

DR. APOSTOLAKIS: Well, I think this could have been input to the PRA. I mean the PRA is not -- you said that they didn't do it. I mean PRA doesn't do -- PRA doesn't do anything. I mean it depends on who does it and what they decide to include.

CHAIRMAN BARTON: George, I'm surprised at you.

PRA doesn't do anything.

DR. POWERS: It's a quote that will live to haunt him.

DR. APOSTOLAKIS: But it is true that the PRA that was presented to us yesterday does not include errors of commission, and again, you have to go with the state of the art. I mean if --

DR. CARROLL: I think we've got a cart and horse situation, too. The PRA predates this effort by a lot, doesn't it?

MR. SCHULZ: It predates this WCAP, yes.

DR. APOSTOLAKIS: Now, the other thing is, though -- well, I mean this qualitative analysis, you know, given the state of the art, the current state of the art, is probably good enough.

Again, I have a problem with the word "credible." I mean, yesterday, we were given probabilities on the order of 10 to the minus 3, 10 to the minus 4, 10 to the minus 5. So, there is no credible concern means, now, what, that you are below that?

MR. SCHULZ: This is obviously qualitative.

DR. APOSTOLAKIS: I understand.

But also yesterday we had situations where yes, automatic actuation failed, now the operators had 10 minutes or 20 minutes to act.

Here, though, you say, if there is a provision for automatic actuation, then that's a safeguard against human error, which is philosophically a little bit at odds with the discussion yesterday, because the human error -- human action yesterday came into the picture after the automatic system failed, whereas today you're saying, if there is an automatic capability, that's a safeguard.

So, there are some inconsistencies there.

Now, I don't know how important they are, but we can't keep silent, right?

So, that -- I guess that's fine.

MR. SCHULZ: Our point of view here was largely in less extreme situations than you get into the PRA, where you have multiple things going wrong.

Now, you do have to consider that in the ERGs, in the whole design of the human factor, man-machine interface.

We were looking here for more can the operators do things in either design basis accidents or more likely things that would cause a problem all by itself?

So, when we use the word "credible" here, it is, first of all, qualitative judgement kind of thing based on these first three columns.

DR. APOSTOLAKIS: I understand.

MR. SCHULZ: That's all it is.

DR. CARROLL: I guess the one thing that goes into the credible discussion is every operator knows how to bypass things if he wants to, and we never consider that, but it's something that happens at times.

DR. APOSTOLAKIS: That's the real concern, really, yes, but we don't know how to analyze that.

DR. CARROLL: It's fine to say it's an automatic trip, but I can make it un-automatic.

DR. APOSTOLAKIS: At the same time, of course, it depends on the operators. They have done things in the past that were innovative and saved the plant, so -- but you're right, that's really the issue, and crazy things have happened sometimes.

So, we're hoping ATHENA will tell us how to handle those things, right?

DR. POWERS: Undoubtedly to three decimal points, right?

MR. SCHULZ: Our conclusion in the human factor-human intervention part of this study was that we didn't see any potential for significant human adverse interactions, and kind of a summary of why that is so is that the passive features require less either automatic or manual actions for them to continue working.

The required actions that -- the actions that are required are automatic, and if they work, then there's really no need for operator action. If they don't work, then you get into some of the beyond-design-basis PRA considerations.

And the ERGs are structured and designed to avoid adverse interactions.

I think there was some discussion yesterday about the goal tree monitoring that goes on independent of the operators that are actually managing the plant in an accident situation, and that's, you know, another example of the procedures and how they attempt to avoid cognitive-type errors.

The final, third part was actually the most straightforward part of the adverse interaction study, looking at spatial-type, hazard-induced interactions, and the studies that are typically done for plants, the fire hazards, the flooding hazards, missiles, seismic pipe breaks, all these, basically their objective is to look for such interactions, high-energy line breaks on non-safety systems and their impact of jetting and flooding on safety systems, so -- and the PRA does some independent look at some of these things, in particular the fire and floods.

So, we basically looked at these hazards analysis, and they all concluded that there weren't any problems with the plant design, and that was pretty much the extent of this part of the study.

The kind of underlying reasons why, you know, there weren't problems in those areas is that the AP600 design has very effective separation, very sort of block-wise kind o' separation, safety division, the division outside containment, non-safety to safety, both.

There's less stuff outside of containment, a lot less stuff to worry about. You don't have the train of cooling water, service water, CCW into the plant, into HVAC, into RHR cooling.

We don't have continuously operating equipment. So, fire and flood effects are somewhat less significant, because once we get our passive systems working, you don't need power to run equipment anymore.

Simplified flood protection -- this actually is related to the passive systems in that we don't have large water supplies outside of containment that are needed to provide safety injection or steam generator feedwater that are located in safety areas that can interact adversely.

Sc, we have a very simple, basically exclude large water supply kind of approach to flooding, and we don't have to worry about as much of that as the current plants do, and we have done some upgrading inside containment on fire protection, which then helps this whole story of minimizing fire-induced interactions.

I think that's the last slide I had, if you have any questions.

DR. FONTANA: What was the WCAP number you were referring to?

CHAIRMAN BARTON: 14477.

MR [illegible]Z: Yes. There's a Rev. 1 that's out on that.

DR. CARROLL: Looks like that's an extra one sitting there if you want it.

CHAIRMAN BARTON: Looks like no further questions, Terry. Thank you.

DR. APOSTOLAKIS: Yes, I would like a copy of that.

CHAIRMAN BARTON: Does the staff have any comments?

MR. HUFFMAN: This is Bill Huffman, Projects.

Allen Levin, with the support of -- you know, it was a cross-section of most of the technical review branches, but Allen Levin was the lead reviewer in this effort, and he agrees with Westinghouse that the design in the event of restart and other proceduralized things that might happen beyond what the design is automatically capable of being done are covered in the ERGs and in the design and there aren't any other adverse interactions that they could find.

CHAIRMAN BARTON: Okay.

Another nice tie today, Mr. McIntyre. You dressed for the occasion.

MR. McINTYRE: Thank you. It's not an engineer's tie.

CHAIRMAN BARTON: That's why I said you dressed for the occasion.

DR. CARROLL: A good-looking tie? Why would you wear something like that?

MR. McINTYRE: Well, people have thought this was my NRC tie, because that's actually an eagle in the center, and I've been accused, and I was thinking about ties this morning.

We had these AP600 ties made up, and they're wonderful, and one of my tasks in life is to get rid of -- I have about 2,000 of them, and they're not exactly going fast, you can only do so much. I think we've actually given them to the NRC. They fit well within the $25 limit.

Actually, they come in two colors. I don't know if they say Westinghouse. They say AP600. I was thinking, since I've got these left, I'll drag a gross of them down and give them to Noel, because they're not violating anything there.

Security -- this is in response to Mr. Carroll's and Mr. Barton's comment of, gee, this plant is really going to be a pain to maintain, and we may have cut down our security force, but our maintenance force is now going to have to have a security force equal to the security force that we thought we were getting rid of to let these guys in, and I'm going to start --

DR. CARROLL: Plus operators, plus fire protection.

MR. McINTYRE: Yes. I'm going to start on the middle slide. That's always a good place to start, because it makes a little more sense there.

This is the 117-foot elevation, and all these nice things aren't colored in on the ones that I handed out, because I wasn't going to color them all. You can color them in if you so desire.

The original design, as you will recall -- and I'll speak mostly to Jay and John, because they were the people who had the concern -- is they had a little jail cage drawn around each one of these that required -- because the guy would leave -- the color code is -- on the red side -- is the vital area, the blue shaded in is the protected area, and what they had before were these little jail cages here, and this one -- right there -- so that if the guy was going to go out to maintain this, he had to go out -- because he was going from the vital area to the protected area, out into the general plant, and then back in again, he had to have a guard, he had to be searched, he had to be looked at, and you guys didn't like that. I guess that's a fair statement.

So, we went back, and it turns out that the design you see here is really the design that the designer originally had, and he was just tickled pink that you guys -- I mean I called back and said, look, they have this problem.

By the time I got back that night, they had this, because the guy had them in a drawer, and he just pulled -- he liked it better and he got talked out of it.

So, after we got over all I-told-you-so's, what we've done is there's a column line right here, and instead of having the jail cages, we're moving to this column line, and it's a floor-to-ceiling -- it's either a steel siding with slots cut in it for ventilation or a wire mesh with intrusion detection.

This whole area is then covered with CCTV so that they can watch to see if people are bothering the doors, but the guy never has to go out to maintain the plant. He'll just go out through these doors and then he can card back in through there, so he never really goes out into the plant. He'll go from the vital area to the protected area back into the vital area again.

DR. SEALE: So, essentially, he has a lock in the form of a card to get through the door.

MR. McINTYRE: Yes, right.

DR. SEALE: He doesn't have to go through --

MR. McINTYRE: Yes. He's searched when he gets into this area.

CHAIRMAN BARTON: He does it one time, then.

MR. McINTYRE: Right. He does it one time, and he can maintain that.

So, this whole area is covered. It's grating on the floor. This is 19 feet, 3 inches, so there's enough room to do maintenance and get things in and out of the room.

You'll see, on this end -- I'm starting on this because -- at this elevation, because the previous elevation doesn't really look significantly different, but to get down to the lower elevation and to the upper elevation, there's a set of stairs right there.

So, now, if you go back to the first slide, you can see that we still have -- getting into the annex building, they still have the jail cage, because that makes sense.

We didn't want to -- one is there's too much equipment, and two is you don't really need to, but we couldn't move all these things. We had to move some equipment.

If you look at the old drawings to the new drawings, there was some equipment that got moved outside of that line. We couldn't move these things. So, this still has the jail cage, but you're not -- there won't be a lot of access into there.

If he wants to get to this room for -- the valve piping penetration room, he would come in from the other elevation and go down the stairs and get to this room, and you'll also see some equipment relocated in that area.

DR. CARROLL: So, I can go down the stairs as opposed to going through the jail cage --

MR. McINTYRE: Yes.

DR. CARROLL: -- anyplace in this --

MR. McINTYRE: Sure. Yes.

DR. CARROLL: -- elevation.

MR. McINTYRE: And then if you look at the 135-foot elevation, it's basically the same. The three jail cages that went to the MSIV rooms are gone. There are the stairs.

And basically, it's the same arrangement, that he would go out through here and then he could just card back in without needing to be searched.

The one other thing that we're doing -- we're having to redo the vulnerability analysis and the security plan as part of this, because it's making a significant change.

You recall, last time I talked, we had added a security officer for other reasons, and we are going to be stationing that security officer right here. So, this will be -- I believe our intent right now -- we're still working on the analysis -- would be to have this -- not only have CCTV but have it continuously manned with an officer in that area.

CHAIRMAN BARTON: So, he would be there to help people --

MR. McINTYRE: Right.

CHAIRMAN BARTON: -- do the ingress and egress --

MR. McINTYRE: Yes.

CHAIRMAN BARTON: -- if they had to go out for material or supplies or whatever.

Has the staff seen this?

MR. McINTYRE: They saw it about an hour ago.

CHAIRMAN BARTON: Okay.

MR. McINTYRE: So, I don't think they'll have any -- well, I'd like the guy to stand -- Ron to stand up and say, boy, that's a tremendous design. He hasn't seen it and certainly hasn't seen the vulnerability analysis, because we don't have it done.

CHAIRMAN BARTON: Well, in our letter, we asked the staff to go look at the previous design from safety and operational aspects, and so, I'd be interested to see what the staff thinks of this.

You know, from this brief description you've given, this looks like a major improvement from what we've seen before. I don't know if it solves all problems. We need the staff to still look at this modified design, but it sure does look like an improvement.

DR. SEALE: Will this involve any changes in the expected staffing level for security?

MR. McINTYRE: No.

DR. SEALE: You can always add, but you can never take away.

CHAIRMAN BARTON: Just like taxes.

MR. McINTYRE: You can't go below a minimum staffing.

DR. CARROLL: Now, I think there's a lesson to be learned here, both on the staff's part and on Westinghouse's part.

When you get into a highly specialized area like security, you've got to be very careful, because your experts tend to want to have the latest and greatest in their opinion, and they don't really have a lot of regard for what else is implied by their design.

MR. McINTYRE: Interestingly enough, the designer who originally had this design was talked out of it by the utility guy.

DR. CARROLL: Well, you hired a consultant.

MR. McINTYRE: No, he was a utility security guy. He was the one who talked him out of it.

DR. SEALE: You just said the magic word.

MR. McINTYRE: Yes.

DR. SEALE: The security guy from the utility.

MR. McINTYRE: Yes. But he is the guy who also has to deal with it in a real-life situation.

DR. SEALE: Maybe he won.

MR. McINTYRE: If you look at the old drawings and the new drawings, it looks like -- this equipment was originally here and there was some other equipment here that looks like it may have disappeared.

CHAIRMAN BARTON: You had to relocate some equipment?

MR. McINTYRE: Yes. What we did is we added another -- it's actually -- the equipment that was here is actually sitting a little bit off the top here, and we added a partial elevation -- I think it was some tanks or some condensers or some sort of equipment that was here.

CHAIRMAN BARTON: Okay.

MR. McINTYRE: These guys were here. They moved over here. The stuff that was here is up.

CHAIRMAN BARTON: He's up a half-a-floor or something.

MR. McINTYRE: These are really a low piece of equipment. They're not very tall. So, we put like a platform to put it up there.

CHAIRMAN BARTON: All right.

MR. McINTYRE: So, this is the proposed change to security. We're in the process of revising the report, and we'll get it in to the NRC, hopefully, in the next couple of weeks

CHAIRMAN BARTON: Looks like an improvement. Thank you.

Any questions?

[No response.]

CHAIRMAN BARTON: Well, we're a little ahead of schedule, but we'll break now until 10:15.

[Recess.]

CHAIRMAN BARTON: Back in session.

I'm sorry, Brian. Next item on the agenda is open items issues.

MR. McINTYRE: Okay.

I gave Noel -- going to the list, there's one four down, SRM on 97-044 staff work to understand marginally adequate, and I think Tom's comment yesterday -- I think this was Tom's comment -- is we were going to talk about that this morning, when Terry did his presentation that had to do with containment spray, that our design was marginally adequate, their terms. Maybe it was your terms, or it was somebody's terms.

CHAIRMAN BARTON: It was Tom Kress' concern.

DR. SEALE: Well, I think the reason was that, in the initial discussion of the capabilities of the spray system, there was some concern as to whether or not it was enough to deliver any significant flow --

MR. McINTYRE: Okay.

DR. SEALE: -- against the internal pressure of the containment.

MR. McINTYRE: Okay.

DR. SEALE: And I guess now you've indicated that it's 3,000 gallons per minute with an internal pressure of 20 psi -- I mean 1,000 gallons a minute with an internal pressure of 20 psi. So, I assume that's an adequate fire-fighting flow.

DR. CARROLL: Fire-fighting?

DR. SEALE: I mean spraying flow.

DR. FONTANA: There's a little bit of a gotcha there, because in a design basis accident, the passive system is supposed to hold containment pressure to 45 psi or less.

MR. McINTYRE: Right.

DR. FONTANA: Okay.

MR. McINTYRE: Okay.

DR. FONTANA: Now say you're near there and then you get into some kind of a glitch for some reason. Now you want to use the spray system that's designed for 20. Can't us~ it.

DR. CARROLL: The whole notion is that you'd never use the spray system for a design basis accident.

CHAIRMAN BARTON: This is really a severe accident.

DR. FONTANA: I understand, exactly. I'm saying you're in a design basis accident and now, for sc.me reason, something's not working right and you want to use the spray system.

CHAIRMAN BARTON: Not designed to do that, Mario. Not intended to do that.

DR. FONTANA: But see, you're not going to be at 45 psi. You're going to be --

MR. McINTYRE: -- something less.

DR. FONTANA: -- something less. If you're at 20, you're okay.

MR. SCHULZ: What we've done is we've tried to mechanistically look at, if you get into core cooling problems, you've got a lot of energy now going into melting the core. It's not going into the containment. The containment brings the pressure down substantially during that damage phase.

So, even if the pressure was up at 45 when you had your loss of core cooling failure, whatever it was, you don't instantly need spray. You don't want spray at that point. You want the spray when the activity comes out. The activity won't come out until after you've damaged the core.

That takes time. During that time, that's energy going into the core, not into the containment, and the pressure comes down. So, there's a mechanistic connection between why you would want the spray -- i.e., the core is damaged -- and the pressure coming down.

DR. FONTANA: See, once you've got the spray going in there, then that will take some containment pressure down. Once you can get it going, you know, you'll be all right.

MR. SCHULZ: And what we're saying is that the passive containment cooling system will bring the pressure down very nicely to this 20-pound gauge in a severe accident sequence.

DR. SEALE: The other question is the 20 -- the three-hour duration of the flow -- or five hours, whichever it turns out to be -- does cover the time span in which you do get delayed gas release, fission product gas release.

MR. SCHULZ: That's my understanding, is that's really where the three hours came from.

DR. SEALE: Yes.

Does that sound right to you, Dana?

DR. POWERS: You'd have to say it again, Bob.

DR. SEALE: The idea that there is a three-hour duration for the spray system following the 1,200-degree core temperature thermo-couple onset of spray covers the time during which you'd expect to get fission gases released.

DR. POWERS: It's really when you have the most intense particle release that the spray's going after, and from everything we have seen, with the new source terms and things like that, which are fairly strongly based on physical evidence from experiments, the most intense releases are occurring in that -- over a two-or-three-hour period, and then you get a pretty dramatic e-folding on the concentrations, and then, if your containment remains intact, all you're worried about is the leakage problem, and clipping the tops on the concentration does a lot for you.

I mean it doesn't take much, and sprays are awfully effective. I mean there are a lot of questions, and some of the chemical engineers phrased questions about -- you've got a lot of droplets coming down, well something's got to go up, and if that going up is not uniform, you create some bypass flow, and they worry about that a lot in the chemical processing industry, but it's not so important in the containment, because it's a sealed up thing.

So, suppose you do have the spray all pushed to one side and stuff coming up. Well, that stuff that comes up n.. has to come back down again.

So, it gets multiple passes through this thing, and so, some of those subtleties that the chemical engineering community worries about, that, for instance, this analysis did not, they're interesting, but they're not terribly germane.

DR. SEALE: You get more than one shot at it.

DR. POWERS: You get multiple shots at the same gas --

DR. SEALE: Yes.

DR. POWERS: -- and maybe you don't know the timing exactly, but you're worrying about big blocks of time, and what happens in any given one minute is pretty inconsequential.

What you're worried about is what happens over 20 minutes, 30 minutes, and hour and whatnot, because it's the leakage-type source term that you're worried about here. If you got containment rupture, that's a bad thing. You didn't want to do that anyway.

DR. SEALE: Well, I think those were the kind of questions that Tom had in mind when he was questioning the efficacy of the spray system, its capacity to handle those kind of issues.

DR. POWERS: Yes. I think, to be quite honest, I believe Dr. Kress was interrogating to find the depth of knowledge rather than any doubts about the efficacy of sprays.

MR. McINTYRE: Did we pass?

CHAIRMAN BARTON: Sounds like you must have.

MR. McINTYRE: Okay.

DR. FONTANA: I have another question here.

Now, the PRA was written prior to the consideration of sprays? In other words, potential spray use is not in the PRA?

MR. McINTYRE: It's not in the PRA.

DR. FONTANA: Okay.

Now, the next question is, does the PRA go along with the certification for -- when a utility buys this, are they going to be probably required to update the PRA?

MR. McINTYRE: The part that goes along with the certification are the insights, which is basically a summary of here are design features that were credited in the PRA that we want to make sure they don't get lost when they update the plant, and whether or not it goes along with design -- you know, what they have to do at design certification time, what we're saying is that they need to make sure that the plant is consistent with the PRA.

DR. FONTANA: Well, the plant's going to be a little different if the PRA's got a spray system in it.

It's not safety-related.

MR. McINTYRE: Well, that won't affect core -- that would only affect --

DR. FONTANA: Oh, no.

MR. McINTYRE: -- the level three.

DR. FONTANA: Yes.

MR. QUAY: This is Ted Quay of the staff.

To answer part of your question, the staff has before it in the rule-making activity plan a rule that would ask for a living PRA.

MR. McINTYRE: I think we can mark that one closed.

CHAIRMAN BARTON: Does that staff have any further comment or question on the spray issue?

MR. KENYON: This is Tom Kenyon with the staff.

No, we found it to be acceptable.

DR. CARROLL: Marginally.

MR. KENYON: Those were your terms.

DR. CARROLL: Oh, okay.

Well, this living PRA concept would not really be back-fittable to the evolutionary plants or to AP600, would it?

MR. QUAY: What it would do is it would tell the COL applicant that they have to maintain the PRA.

So, it would be -- in other words, it wouldn't be backfit to the design certification, but as these plants are going through the licensing process, if any changes are made, that PRA would have to be updated. But that's in the rule-making activity plan.

DR. SEALE: Is that for Part 52 plants or all plants?

MR. QUAY: That's Part 52 plants.

DR. SEALE: Okay.

DR. CARROLL: Is that really consistent with the notion of one-stop licensing?

MR. QUAY: The certification stands as is. The certification would not change.

MR. McINTYRE: It's not inconsistent. It's more in line with risk-informed, performance-based regulation.

The next item was the -- Westinghouse agreed to discuss the suitability of results of reactivity code, and yesterday, Dr. Powers said tell me what data facts you used, and the next question is why.

Noel has to hand out from the SSAR the page 15.4-36, and it is subsection -- I love this -- 15.4.8.2.1.4, which is why we thought it would be easier to hand it out, and I even underlined the answer, so we don't have to look, and it says, just reading it, "To allow for future cycles, pessimistic values of beta effective of .55 percent at the beginning of cycle and .44 percent at end of cycle are used in the analysis," and I'll speak for Dr. Powers -- I'm sure he won't be bashful here.

He said yes, that does, indeed, answer the question, so -- and it explains the why we used it.

His one comment he did have was that he thought that perhaps those values were high when we start looking at high burn-up fuels, but that really probably isn't an AP600 issue as much as that it's going to be an extended burn-up fuel issue.

CHAIRMAN BARTON: Okay.

MR. McINTYRE: I'll ask him if he considers it closed.

CHAIRMAN BARTON: Dana?

DR. POWERS: Yes. I hate to say this, but I think I agree with Brian on this one.

DR. SEALE: Spooky.

DR. POWERS: There must be something wrong with my thinking today, but I guess I -- they strike me as conservative for the BOL and optimistic for the long-term burn-ups, but I agree with him, things are sufficiently unresolved enough in that are for the high burn-up fuels, and it's sufficiently -- and whatever happens, we know that the fuel that's going to be used for extended burn-up in an AP600 reactor is going to be different from any of the fuels that we have now, and so, it would be pointless for

Westinghouse to go to great heroic lengths to address those fuels, and they're going to have to be addressed as part of the loading process anyway, and so, I guess I -- I also know that the analyses that are done in the design basis analysis don't give them credit for energy losses into the clad anyway, regardless of the pulse width.

So, I think it's a closed issue here but one to be aware of when we go to loading high burn-up fuel. But I'm sure that that will come of its natural course.

CHAIRMAN BARTON: All right.

MR. McINTYRE: The next open one is the locked rotor peak clad temperature, and I mentioned that we're working on that one, and we'll submit that in a written form, and on the second page, the security design --

CHAIRMAN BARTON: Did we close out Carroll's item on the adverse interactions?

DR. CARROLL: As far as I'm concerned.

CHAIRMAN BARTON: You missed one here, Brian.

MR. McINTYRE: Well, I already had it closed out.

CHAIRMAN BARTON: Oh, you already did. Okay.

DR. CARROLL: Simply because you got up there and talked, you're going to close it out?

CHAIRMAN BARTON: Jay, are you happy?

DR. CARROLL: Yes.

CHAIRMAN BARTON: Okay.

DR. CARROLL: I thought they did a very comprehensive job on that. I'm impressed.

CHAIRMAN BARTON: I'm sorry. Where are you going next, Brian?

MR. McINTYRE: We'll thank Mr. Corelleti for you. I remember, last time, Mr. Corelleti was substituting for Mr. Schulz. Mr. Schulz is returning the favor, so Mr. Corelleti can be in Italy or Spain.

The other ones on the next page, security design --

CHAIRMAN BARTON: Yes, marked improvement.

Is the staff still looking at this, though?

DR. CARROLL: Yes, they're doing a vulnerability -- Westinghouse is doing a vulnerability analysis.

MR. KENYON: We're going to be looking at it probably -- we'll get the vulnerability analysis from Westinghouse about the end of June sometime. So, we can make a comment on it at the July meeting.

CHAIRMAN BARTON: Okay.

MR. McINTYRE: And we picked up one yesterday from Mr. Carroll that a three-hour fire door is not a smoke door and how do you deal with that, and I think we've answered that before. We'll talk to Mr. Winters when we get back to Westinghouse and provide an answer on that.

And this morning, Dr. Powers wanted to know what G value we used in the nitric acid calculations. My person back at Westinghouse is looking for that.

The calc note happens to be in our Rockville office. I will scoot out there over my lunch hour and drag the calc note back and find something in there that says G equals and pass that along to you right after lunch.

DR. POWERS: See the penalties you get when I agree with you?

MR. McINTYRE: These meetings are like scavenger hunts.

So, we're down to a couple of items here.

CHAIRMAN BARTON: Okay.

Looks like we ran out of agenda items here.

Let's talk a little bit about the July meeting, what we've still got left to do in July.

DR. CARROLL: We're not going to do aerosols?

CHAIRMAN BARTON: Where do you see aerosols?

DR. CARROLL: Items five and six.

CHAIRMAN BARTON: That's getting resolved in Germany. So, we'll probably hear when the troops return from Germany.

DR. CARROLL: You're not going to trust Kress' judgement, are you?

CHAIRMAN BARTON: Well, I don't know, at this time, what else we've got to go by. Westinghouse's people are over there, I guess, Kress is over there.

MR. McINTYRE: The staff guy is over there.

CHAIRMAN BARTON: Staff is over there. The only person that knows anything about aerosols here is Dana, and he'll be talking to himself, I guess, if we talked about the aerosol issue.

DR. POWERS: I have to recuse myself completely from that.

CHAIRMAN BARTON: I think aerosols is a dead issue for today's meeting.

DR. SEALE: If he does talk, it's just a mumble.

DR. POWERS: I will tell everybody about some exciting news that we are getting out of the -- apparently coming from some of the PHEBUS tests, giving us some information on shape factors that may be pertinent to aerosol behavior in the AP600 containment.

The shape factors are running between two and three from the PHEBUS experiments. That's exciting to me, simply because those are numbers that the staff used in their analysis. I have no idea where they got those numbers.

DR. CARROLL: Good guess.

DR. POWERS: And it's a brilliant model and deductive science that someone somewhere applied to the staff's analysis.

DR. FONTANA: Shape factor goes up. Is that better or worse? Shape factor goes from assumed -- something's assumed spherical to something else. Is that correct?

DR. POWERS: Well, that's one view on shape factor. Shape factor is a little more complicated than that.

The simplest way to understand shape -- shape factors are a way to deal with the fact that the aerosol physics models are all based on the behavior of spheres, and aerosol particles aren't spheres, and the simple use of shape factors and where they originally arose was in describing gravitational settling, and bigger shape factors mean slower settling, so you have higher concentrations in the atmosphere and lower concentrations on the floor.

So, it depends on where you're worried.

If you're worried about dose effects on water solutions and things like that, then big shape factors slow that process down.

If you're worried about concentrations in atmospheres and gravitational settling is your predominant concern, then big shape factors mean you have higher concentrations for longer periods of time in your reactor containment.

Shape factors have very small effect in sprays.

They will -- collision shape factors will enhance removal due to interception. Other than that, they're -- sprays are like hitting it with a sledgehammer, and it kind of ignores subtleties.

AP600 is not -- is unusual. It has a huge containment, and you'd ordinarily say gravitational settling is the dominant removal mechanism, but it's a cold containment, and if, indeed, the thermal hydraulics in the containment are correctly portrayed, then the dominant removal mechanism is a diffusio-phoretic force on the particles, and diffusio-phoresis and shape factors are things that just don't mesh well. They are two concepts that just have never interacted especially well.

If you take a simplistic view and say shape factors are shape factors are shape factors, then shape factors tend to slow down the diffusio-phoretic removal.

DR. FONTANA: Steam sweeping them toward the wall.

DR. POWERS: That's right.

DR. FONTANA: A higher shape factor tends to slow that down?

DR. POWERS: Yes. Because you've got steam coming in, that means you have to have a gas coming off to keep pressure balanced, and so gas is pushing particles out, it's got more to push on. It becomes a complicated analysis.

But what the staff showed in their analysis, in comparison to Westinghouse's analysis, even though they used different assumptions on the shape factors and things like that, they got about the same amount of removal, and so, it was about the same result.

it depends directly on the thermal hydraulics in the containment, but if everybody agrees on that, then the aerosol physics, everybody kind of agrees.

Is that a correct characterization?

MR. McINTYRE: I believe that's correct, or fair.

CHAIRMAN BARTON: We do have a meeting scheduled in July, a subcommittee, for the 6th and 7th, and some discussion with Noel and the staff -- it doesn't look like we've got two days worth of issues still on the plate here. It looks more like maybe one day of subcommittee work prior to full committee on July 8th, I believe, is the full committee. So, it looks now like we will be maybe having a subcommittee meeting on the 7th, instead of 6th and 7th, and then the full committee will start on the 8th.

We've got some thermal hydraulic issues, some open questions

Noel, what else is there?

MR. DUDLEY: That's it, unless members have any other issues that they need to --

CHAIRMAN BARTON: -- to bring up at that time.

MR. DUDLEY: -- bring up or get answers for. So, this is an opportunity to identify any other questions you have on the AP600 design so that the staff and Westinghouse can respond, prepare to respond to those in the July meeting.

CHAIRMAN BARTON: Now, for the full committee in July, Brian, I think, based on members that are absent, probably an overview of the ITAAC, adverse system interaction, and I don't think we need four hours of PRA level one, but I think enough of the level one to let the members that missed yesterday's presentation get a sense for, you know, how thorough the level one PRA was done. I think there was a real good job yesterday, but I don't think we need that much time on it. You don't have that much time on July 8th at the full committee meeting.

What are we allowing them on July 8th? A couple of hours?

DR. SEALE: Yes.

CHAIRMAN BARTON: So, you've got ITAAC, adverse system, PRA, plus whatever cats and dogs come up between now and then --

MR. McINTYRE: Okay.

CHAIRMAN BARTON: -- for the July 8th meeting.

MR. McINTYRE: It would be useful for the subcommittee meeting on the 7th if we could get those as soon as -- anything that you want to hear about, because we need to know what -- you're getting to the end when you get to cats and dogs. We have to bring an army, and while Mr. Schulz is yeoman, some of these are not necessarily his area.

DR. CARROLL: He fakes it pretty good.

MR. McINTYRE: Yes, he does.

So, rather than -- we can't have any unanswered questions at the end of that.

So, anything that comes up, we may bring the army anyway. I don't know, we'll see, but if you guys have any questions, let us know.

CHAIRMAN BARTON: All right.

DR. FONTANA: So, it's definite now? We've changed travel and have only a meeting on the 7th.

CHAIRMAN BARTON: I don't see a need for a two-day subcommittee. We had this laid out way in advance, the subcommittee meeting, and it just looks like there's not that much left out there. We can't support a two-day subcommittee.

I think, you know, if we got one day to wrap up open issues, that would probably be plenty of time we would need for subcommittee.

CHAIRMAN BARTON: Has the thermal hydraulic subcommittee finished their --

I think they've had all their meetings. They've got some issues and questions, I believe.

MR. McINTYRE: I think I can speak to that.

MR. DUDLEY: My understanding from talking to Paul is that he will need about two to three hours during the July meeting, the July 7th subcommittee meeting, to clean up his items.

CHAIRMAN BARTON: Okay. So, it looks like maybe a full day on the 7th should do it.

Don, you had something?

DR. MILLER: I just already scheduled a meeting the afternoon of the 7th, but it doesn't sound like I'm going to be needed anyway.

CHAIRMAN BARTON: At this point, do we need the recorder anymore?

DR. CARROLL: I guess I have one thing for the staff.

You're going to review the vulnerability analysis for security when submitted by Westinghouse. Are you also going to show the design to some of your more operationally oriented people to see if they can find any glitches in the new design?

MR. McINTYRE: I don't know that the vulnerability analysis would help the operational people much, because what that is is, given a threat, how quickly we can respond to it.

DR. CARROLL: Yes. Well, I'm just saying, in conjunction with that, are they going to --

MR. KENYON: I understand your question, and the focus of the staff is going to be, now that Westinghouse has proposed a fix or design modifications to address the particular issue you've raised -- it's not our intent to go back and take a look at the rest of the design in terms of, you know, operability ease or maintenance ease.

It goes back to what we were talking about at the last -- or one of the former subcommittee meetings. If they meet the regulations, if an inconvenience because of maintenance, it's not a problem with the staff.

DR. CARROLL: To me, it's potentially a real safety issue, Tom. If the operators are going to be delayed in getting to equipment --

MR. KENYON: I don't have the security man here, but he'll tell you, when there is a problem of operability and there is a need to get access to this equipment, a lot of the security -- it's my understanding that a lot of the security requirements are temporarily put on hold.

DR. CARROLL: That's correct. You can throw a switch and open the doors.

MR. KENYON: So, we're looking at it from the perspective of addressing the particular concern.

We understand and agree with you that it was a good idea to make the modification, but other than that, we feel that the other security measures that are in place and the capability to remove security requirements in case of emergency meet the regulations and are adequate.

DR. CARROLL: Okay.

CHAIRMAN BARTON: Any other discussion questions at this time with Westinghouse or the staff? If not, I don't think we need the recorder anymore.

[Whereupon, at 10:47 a.m., the meeting was concluded.]

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